



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Bailey III et al.

Attorney Docket No.:
LAM1P128/P0561

Application No.: 09/440,794

Examiner: Anderson, Matthew A.

Filed: November 15, 1999

Group: 1765 ✓

Title: MATERIALS FOR GAS CHEMISTRIES
FOR PROCESSING SYSTEMS

Confirmation No.: 3445

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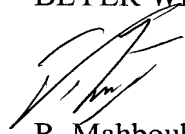
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex Parte Andrew D. Bailey III, et al.

Application for Patent

Filed: November 15, 1999

Application No.: 09/440,794

Group Art Unit: 1765

Examiner: Matthew A. Anderson

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For: MATERIALS AND GAS CHEMISTRIES
FOR PROCESSING SYSTEMS

APPEAL BRIEF

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1. REAL PARTY IN INTEREST

The real party in interest is the assignee, Lam Corporation, Inc.

2. RELATED APPEALS AND INTERFERENCES

This application is related to issued patents: U.S. Patent No. 6,341,574, issued on January 29, 2002; U.S. Patent No. 6,302,966, issued on October 16, 2001; U.S. Patent No. 6,320,320, issued on November 20, 2001; U.S. Patent No. 6,322,661, issued on November 27, 2001; and pending U.S. patent application No. 09/470,236, filed on November 15, 1999.

However, it is believed that there are no other appeals or interferences which will directly affect or will be directly affected by or have a bearing on the Board's decision in the pending appeal.

3. STATUS OF CLAIMS

Currently, claims 31-45 and 49-56 are pending and all are being appealed. The claims on appeal are reproduced below in Appendix A.

4. STATUS OF AMENDMENTS

All amendments to the claims have been entered.

5. SUMMARY OF INVENTION

The invention relates to techniques for processing substrates (e.g., semiconductor substrates for use in integrated circuits). One aspect of the invention pertains to improved plasma processing techniques. The techniques provide a higher degree of processing uniformity across the substrate placed in a plasma processing chamber. (Specification, page 1, line 25 to page 2, line 4).

As such, claim 31 pertains to a method for controlling processing uniformity while processing a substrate. The method includes the acts of providing a plasma processing chamber within which a plasma is both ignited and sustained during processing of a substrate, providing a coupling window disposed at an upper end of the plasma processing chamber, and providing an RF antenna arrangement disposed above the plane defined by the substrate when the substrate is disposed within the plasma processing chamber for processing.

It should be noted that claim 31 also recites providing an electromagnet arrangement disposed above the plane defined by the substrate. As will be appreciated, the electromagnet arrangement is configured so as to result in a radial variation in the controlled magnetic field at different radial locations above the substrate when at least one direct current is supplied to the electromagnet arrangement. The radial variation being affects the density of the plasma. This in turn effects processing uniformity across the substrate. Thus, controlling the radial variation in the controlled magnetic field can result in improving processing uniformity.

Claim 31 further recites flowing reactant gases into said plasma processing chamber. The reactive gases include two or more gases with formulas conforming to $C_x F_y H_z O_w$ gas chemistry. Representatives of the gas chemistries are recited, for example, in claims 35, 36 or 37. In any case, it is important to note that the radial variation in the controlled magnetic field is changed when the reactant gas chemistries are flown into the processing chamber. (Please see, claim 31). In other words, the combination of the radial variation in the controlled magnetic field and the gas chemistries are

utilized to achieve the desired result (i.e., improve processing uniformity across the substrate). As a result, the processing uniformity across the substrate can be further improved.

It should also be noted that in some of the dependent claims recite the material used to form the chamber (or at least the inner surface of the chamber. For example, claim 49 recites that at least the inner surface of the chamber can be made of a material that does not substantially interact with the claimed reactive gas chemistries that are flown into the plasma processing chamber when the radial variation in the controlled magnetic field is changed.

In summary, the claimed invention, among other things, provides the features of (a) a radial variation in a controlled magnetic field in conjunction with (b) suitable gas chemistries and/or (c) suitable material used to form the plasma processing chamber. The combination of two or more of these claimed features can be used to affect plasma density processing uniformity across the substrate. As a result, processing uniformity across the substrate is achieved.

6. ISSUES

(1) The first issue presented on appeal is whether claims 31-35 are obvious over U.S. Patent No. 6,085,688 (*Lymberopoulos et al.*) in view of U.S. Patent No. 6,217,786 B1 (*Hills et al.*).

(2) The second issue presented on appeal is whether claims 36-41 are obvious over U.S. Patent No. 6,085,688 (*Lymberopoulos et al.*) in view of U.S. Patent No. 6,217,786 B1 (*Hills et al.*) and U.S. Patent No. 6,254,966 (*Kondo*).

(3) The third issue presented on appeal is whether claims 42-45 are obvious over U.S. Patent No. 6,085,688 (*Lymberopoulos et al.*) in view of U.S. Patent No. 6,217,786 B1 (*Hills et al.*) and European Patent No. 821397 (*Lu*).

(4) The Fourth issue presented on appeal is whether the Examiner's rejection of claim 31 under 35 U.S.C. §112, first paragraph, is proper.

7. GROUPING OF CLAIMS

Claims 31-35 are grouped together and presented as the first group. Similarly, claims 36-41 are presented as the second group. Finally, claims 42-45 are presented as the third group.

8. ARGUMENT

A. INTRODUCTION

In the Final Office Action, the Examiner has rejected claims 31-35 (represented in the first group) as being obvious over U.S. Patent No. 6,085,688 (*Lymberopoulos et al.*) in view of U.S. Patent No. 6,217,786 B1 (*Hills et al.*)

In addition, the Examiner has rejected claims 36-41 (represented in the second group) as being obvious over U.S. Patent No. 6,085,688 (*Lymberopoulos et al.*) in view of U.S. Patent No. 6,217,786 B1 (*Hills et al.*) and U.S. Patent No. 6,254,966.

Claims 42-45 (represented in the third group) have been rejected as being obvious over U.S. Patent No. 6,085,688 (*Lymberopoulos et al.*) in view of U.S. Patent No. 6,217,786 B1 (*Hills et al.*) and European Patent No. 821397 (*Lu*).

Claim 31 has been rejected by the Examiner under 35 U.S.C. §112, first paragraph, as containing subject matter not described in the specification. Contrary to the Examiner's assertion, it will show that all of the rejections are improper and the claimed invention is patentable over the cited art.

First, regarding the first group (claims 31-35), it will be argued that *Lymberopoulos et al.* does not teach or suggest changing a controlled magnetic field in different radial locations in the context of the invention.

Second, regarding the first group (claims 31-35), it will be argued that the *Hills et al.* does not teach or suggest flowing two or more $C_x F_y H_z O_w$ reactant gases in the context of the claimed invention.

Third, regarding the first group (claims 31-35), it will be argued that the combination of *Lymberopoulos et al.* and *Hills et al.* do not teach or suggest changing the radial variation in a controlled magnetic field when the claimed reactant gas chemistries are being flown in order to improve processing uniformity across the substrate.

Fourth, regarding the second group (claims 36-41), it will be argued that the combination of *Lymberopoulos et al.*, *Hills et al.*, and *Kondo* do not teach or suggest changing the radial variation in a controlled magnetic field when the claimed reactant gas chemistries are being flown in order to improve processing uniformity across the substrate.

Fifth, regarding the third group (claims 42-45), it will be argued that the combination of *Lymberopoulos et al.*, *Hills et al.*, and *Lu et al.* do not teach or suggest combining radial variation in a controlled magnetic field with the claimed reactant gas chemistries, and the claimed material for the inner surface of the plasma processing chamber in order to improve processing uniformity across the substrate.

Finally, regarding the rejection of claim 31 under 35 U.S.C. 112, first paragraph, it will be argued that the feature of at least one radial region which is not in an axial direction perpendicular to the substrate is supported pursuant to 35 U.S.C. 112, first paragraph.

B. LYMBEROPOULOS ET AL. DOES NOT TEACH OR SUGGEST CHANGING A CONTROLLED MAGNETIC FIELD IN DIFFERENT RADIAL LOCATIONS IN THE CONTEXT OF THE CLAIMED INVENTION

Claim 31 pertains to a method for controlling processing uniformity while processing a substrate in a plasma processing chamber. Claim 31, among other things, recites providing an electromagnet arrangement disposed above a plane defined by a substrate in the plasma processing chamber. The electromagnet arrangement is configured to result in a radial variation in a controlled magnetic field at different radial locations above the substrate. This radial variation affects density of the plasma in a region proximate to a coupling window and antenna provided in the plasma processing chamber. (Claim 31)

It should be noted that claim 31 additionally recites changing the radial variation in the controlled magnetic field within the plasma processing chamber in a region proximate to the antenna to control the density of the plasma when reactant gases are being flown in the plasma processing. This results in improving processing uniformity across the substrate. It should also be noted that claim 32 further clarifies that the different radial locations include at least one radial region that is not in an axial direction perpendicular to the substrate. (Claim 31)

In the Final Office Action, the Examiner has asserted that *LyMBERopoulos et al.* teaches changing the radial variation in a controlled magnetic field at different radial locations, including at least one radial region which is not in an axial direction perpendicular to the substrate, to effect density of plasma, thereby improving processing uniformity across the substrate. (Final Office Action, page 3)

Initially, it is respectfully submitted that *LyMBERopoulos et al.* pertains to reducing uneven charge build up that occurs at a given feature. (Please see, for example, Fig. 1 of *LyMBERopoulos et al.* illustrating an uneven charge build up in a single contact hole). Contrary to the Examiner's assertion, it is

respectfully submitted that controlling the uniformity of charge distribution does not necessarily result in improved uniformity of the etch process. In other words, the cause of uneven charge distribution on an etched feature is not plasma uniformity. As is known in the art, "uneven charge build up" and "plasma uniformity" are different concepts.

The uneven charge distribution is caused by the difference in random velocities of electrons and/or ions. As noted by *Lymberopoulos et al.*, controlling the magnetic field can result in controlling electron temperature and ion density near by the surface of the substrate. (*Lymberopoulos et al.*, Abstract). Accordingly, it is respectfully submitted that the main objective of *Lymberopoulos et al.* is not improving processing uniformity across the substrate. The main objective of *Lymberopoulos et al.* is controlling uneven distribution on an etched feature. Uneven charge distribution is related to electron temperature and ion density. As such, *Lymberopoulos et al.* teaches controlling of magnetic field to reduce uneven charge build up occurring at a feature (*Lymberopoulos et al.*, Abstract).

It is noted that *Lymberopoulos et al.* merely states that in addition to reducing uneven charge build up, the magnetic field can be used to selectively control plasma density (*Lymberopoulos et al.*, Col. 10, lines 9-21). However, it should also be noted that *Lymberopoulos et al.* does not elaborate further or teach that the magnetic field should be used any differently than is used to reduce uneven charge build up in order to control plasma density. As such, the only reasonable assumption is that *Lymberopoulos et al.* teaches using the magnetic field in the same manner as it used to reduce uneven charge build up in order to selectively control plasma density. Moreover, *Lymberopoulos et al.* specifically teaches that the magnetic field generated within the plasma reactor should have lines of force oriented perpendicular to the substrate surface (*Lymberopoulos et al.*, Abstract). This is further evident because all of the magnetic fields illustrated in *Lymberopoulos et al.* have lines of force oriented perpendicular to the substrate surface. (*Lymberopoulos et al.*, Fig 10, 11, 12 and 13).

In the Final Office Action, the Examiner has asserted that the magnetic field taught by *Lymberopoulos et al.* does not need to be perpendicular to the

substrate. To support this assertion, the Examiner has referenced Fig. 11 and Col. 7, lines 24-31 of *Lymberopoulos et al.* (Final Office Action, page 3). It is respectfully submitted that, contrary to the Examiner's assertion, Fig. 11 or the recited sections of *Lymberopoulos et al.* do not teach or suggest that the magnetic field can be non-perpendicular to the substrate surface.

Moreover, it is respectfully submitted that *Lymberopoulos et al.* teaches using magnetic field lines that are perpendicular to the substrate surface in order to achieve its main objective (i.e., reducing uneven charge build up occurring at a feature). *Lymberopoulos et al.* clearly states that the magnetic field generated within the plasma reactor should have lines of force oriented perpendicular to the substrate surface (*Lymberopoulos et al.*, Abstract).

This is further evident from Fig. 10, 11, 12 and 13. It should be noted that the lines of magnetic force (146) illustrated in Fig. 11 are also perpendicular to the substrate (130). In contrast, for example, Fig. 2A and 2B of the present application illustrate lines of magnetic field at different radial locations. Clearly, these lines include radial locations that are not in an axial direction perpendicular to the surface of the substrate.

It should be noted that claim 31 recites that the electromagnet arrangement is configured so as to result in a radial variation in the controlled magnetic field at different radial locations above the substrate. The Examiner has not properly addressed this feature. As such, the rejection of claim 31 is improper and should be withdrawn at least for this reason alone. Moreover, there is no teaching in *Lymberopoulos et al.* with respect to a controlled magnetic field at different radial locations above the substrate. This is believed to be evident because *Lymberopoulos et al.* teaches using magnetic field lines that are perpendicular to the substrate surface. In fact, *Lymberopoulos et al.* teaches away from controlling magnetic field at different radial locations above the substrate. Hence, *Lymberopoulos et al.* cannot possibly be modified or combined with another reference to teach controlling magnetic field at different radial locations above the substrate in the context of the claimed invention.

In view of the foregoing, it is respectfully submitted that *Lymberopoulos et al.* does not teach or suggest changing a radial variation in a controlled magnetic field in different radial locations. Hence, it is respectfully submitted that the rejection of claims 31 and its dependent claims under 35 U.S.C. §103 is improper and should be withdrawn. Further, it is respectfully requested that the Board reverse the Examiner's rejection and remand the application to the Examiner with directions to allow the claims.

C. HILLS ET AL. DOES NOT TEACH OR SUGGEST FLOWING TWO OR MORE C_x F_y H_z O_w REACTANT GASES

In addition to the limitations discussed above, claim 31, also recites flowing reactant gases into the plasma processing chamber including a combination of gases that includes two or more C_x F_y H_z O_w gases.

In the Final Office Action, the Examiner has admitted that *Lymberopoulos et al.* does not teach flowing the claimed gas chemistries. (Final Office Action, page 4). Initially, it is respectfully submitted that this serious deficiency of *Lymberopoulos et al.* cannot possibly be cured by *Hills et al.* Nevertheless, the Examiner proposes to combine *Hills et al.* in order to overcome this deficiency. The Examiner has made the assertion that *Hills et al.* teaches flowing reactant gases into a plasma processing chamber including a combination of gases that includes two or more C_x F_y H_z O_w gases. However, the Examiner has not provided support for this assertion. Accordingly, it is respectfully submitted that rejection of claim 31 is improper for least this reason and should be withdrawn.

Moreover, it is respectfully submitted that *Hills et al.* does not teach flowing reactant gases into the plasma processing chamber including a combination of gases that includes two or more C_x F_y H_z O_w gases. It is noted that *Hills et al.* describes flowing an etching gas that includes a fluorocarbon gas, N₂ and O₂. (*Hills et al.*, Abstract). It is further noted that fluorocarbon gas includes a C_nF_m gas, wherein n is at least 2 and m is greater than n. (*Hills et al.*, Col. 4, lines 57-59). The fluorocarbon gas can, for example, be C₂F₆,

C₃F₆, or C₄F₈. However, it is respectfully submitted that *Hills et al.* does not teach flowing combination of reactant gases that includes two or more fluorocarbon gases. Thus, *Hills et al.* cannot possibly teach or suggest flowing two or more C_x F_y H_z O_w gases (e.g., C₅F₈+CF₄+CHF₃+CH₂F₂, C₄F₈+CF₄+CHF₃+CH₂F₂, C₄F₆+CF₄+CHF₃+CH₂F₂, etc.)

Hills et al. teaches flowing the combination of C_x F_y + N₂ + O₂ reactant gases. Clearly, *Hills et al.* does not teach using two or more C_x F_y H_z O_w gases. This is evident because *Hills et al.* proposes to use a single fluorocarbon gas. It should also be noted that *Hills et al.* suggests that the fluorocarbon gas can be combined with Nitrogen (N₂) and Oxygen (O₂) in order to achieve the desired result (i.e., controlling critical dimension and bow reduction). In fact, *Hills et al.* states that Oxygen (O₂) and Nitrogen (N₂) should be flown with the fluorocarbon gases to achieve the desired results and avoid adverse side effects. (*Hills et al.*, Col. 5, lines 31-42). Accordingly, it is respectfully submitted that *Hills et al.* teaches away from using two or more C_x F_y H_z O_w gases because it suggests that increasing the flow of Fluorocarbon cases with Oxygen tends to result in greater loss of critical dimension control. (*Hills et al.*, Col. 5, lines 34-37). It should be noted that the main objective of *Hills et al.* is controlling the critical dimension.

In view of the foregoing, it is respectfully submitted that *Hills et al.* does not teach or suggest flowing reactant gases into the plasma processing chamber including a combination of gases that includes two or more C_x F_y H_z O_w gases. Accordingly, it is respectfully submitted that the rejection of claims 31 and its dependent claims under 35 U.S.C. §103 is improper and should be withdrawn. Furthermore, it is respectfully requested that the Board reverse the Examiner's rejection and remand the application to the Examiner with directions to allow all claims.

D. THE COMBINATION OF LYMBEROPOULOS ET AL. AND HILLS ET AL. DOES NOT TEACH OR SUGGEST CHANGING THE RADIAL VARIATION IN A CONTROLLED MAGNETIC FIELD WHEN THE CLAIMED REACTANT GAS CHEMISTRIES ARE FLOWN IN ORDER TO IMPROVE PROCESSING UNIFORMITY ACROSS THE SUBSTRATE.

It should be noted that claim 31, among other things, recites changing the radial variation in the controlled magnetic field within the plasma processing chamber in the region proximate to the antenna to control the density of plasma when the reactant gases are being flown in the plasma processing ,and thereby improving processing uniformity across the substrate. In other words, the combination of the controlled magnetic field and the claimed gas chemistries are used together in order to improve processing uniformity across the substrate.

The Examiner has admitted that *Lymberopoulos et al.* is completely silent as to the claimed gas chemistries. (Final Office Action, page 4). As such, it is respectfully submitted that in order to make a prima facie case of obviousness, the Examiner needs to at least assert that *Hills et al.* teaches using the particular claimed gas chemistries to improve processing uniformity across the substrate chamber. Instead, the Examiner has merely asserted that it would have been obvious to one skilled in the art at the time of the invention to flow the claimed gas chemistries because these gases were known to *Hills et al.* and their use would have been anticipated to produce the expected result of dry plasma etching (Office Action, page 5). As such, the Examiner has not even asserted that the claimed gas chemistries were known to improve processing uniformity across the substrate chamber.

Accordingly, it is respectfully submitted that the Examiner has failed to establish a factual basis to support the legal conclusion of obviousness. (Please see, for example, *In re Fine*, 837 F.2d 1071, 1073, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). In addition, the Examiner is expected to make the factual determination set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 17,

148 USPQ 459, 467 (1966), and to provide a reason why one having ordinary skill in the pertinent art would have led to modify the prior art or to combine prior art references to arrive at the claimed invention. Such reason must stem from some teaching, suggestion or implication in the prior art as a whole or knowledge generally available to one having ordinary skill in the art. *Uniroyal, Inc., v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 1051, 5 USPQ2d 1434, 1438 (Fed. Cir.), cert. denied, 488 U.S. 825 (1988); *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 293, 227 USPQ 657, 664 (Fed. Cir. 1985), cert. denied, 475 U.S. 1017 (1986); *ACS Hosp. Sys., Inc. v. Montefiore Hosp.*, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). These showings by the examiner are an essential part of complying with the burden of presenting a prima facie case of obviousness. Note *In re Oetiker*, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992). If that burden is met, the burden then shifts to the applicant to overcome the prima facie case with argument and/or evidence. Obviousness is then determined on the basis of the evidence as a whole and the relative persuasiveness of the arguments. See *Id.*; *In re Hedges*, 783 F.2d 1038, 1039, 228 USPQ 685, 686 (Fed. Cir. 1986); *In re Piasecki*, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); and *In re Rinehart*, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976).

Furthermore, it is respectfully submitted that the assertion that a feature in itself may be known does not establish that the feature in combination with other recited features would have been obvious within the meaning of 35 U.S.C. §103.

Accordingly, it is respectfully submitted that the Examiner has not established a motivation or suggestion to combine the references. As such, the Examiner has not met the burden of presenting a prima facie case of obviousness. Hence, the rejection of claims 31 and its dependent claims under 35 U.S. C 103(a) is improper and should be withdrawn.

Moreover, it is earnestly believed there is no motivation or suggestion to combine the references to achieve the combination of the controlled magnetic field and the claimed gas chemistries in order improve processing uniformity across the substrate. This is believed to be evident because the

objective of *Hills et al.* is not to improve processing uniformity across the substrate chamber. Instead, *Hills et al.* pertains to mechanism for bow reduction and critical dimension control. As such, it is earnestly believed that *Hills et al.* does teach or suggest using the claimed gas chemistries to improve processing uniformity across the substrate. Hence, it is respectfully submitted that claim 31 and its dependent claims are patentable over the combination of *Lymberopoulos et al.*, and *Hills et al.* for at least these reasons.

In view of the foregoing, it is respectfully submitted that the rejection of claims 31 and its dependent claims under 35 U.S.C. §103 is improper and should be withdrawn. Further, it is respectfully requested that the Board reverse the Examiner's rejection and remand the application to the Examiner with directions to allow all claims.

E. THE COMBINATION OF LYMBEROPOULOS ET AL., HILLS ET AL. AND KONDO DO NOT TEACH OR SUGGEST CHANGING THE RADIAL VARIATION IN A CONTROLLED MAGNETIC FIELD WHEN THE CLAIMED REACTANT GAS CHEMISTRIES ARE FLOWN IN ORDER TO IMPROVE PROCESSING UNIFORMITY ACROSS THE SUBSTRATE.

In addition to the features recited in claim 31, claim 36 recites that the reactant gases include a gas that is that is selected from a group of gases consisting of C₂HF₈, C₂HF₅, CHF₃, C₂H₂F₂, C₂H₂F₄ and CH₂F₂.

The Examiner has admitted that *Lymberopoulos et al.* and *Hills et al.* do not teach the claimed gas chemistries. (Final Office Action, page 5). As such, it is respectfully submitted that in order to make a prima facie case of obviousness, the Examiner needs to at least assert that *Kondo* teaches using the particular claimed gas chemistries to improve processing uniformity across the substrate chamber. Instead, the Examiner has merely asserted that it would have been obvious to one skilled in the art at the time of the invention to flow the claimed gas chemistries because these gases were known for use in plasma etching and their use would have been anticipated to

produce an expected result. (Office Action, page 5) As such, the Examiner has not even asserted that the claimed gas chemistries were known to improve processing uniformity across the substrate chamber.

Moreover, it is earnestly believed there is no motivation or suggestion to combine the references to achieve the combination of the controlled magnetic field and particular claimed gas chemistries that are used in order to improve processing uniformity across the substrate. This is believed to be evident because the objective of *Kondo* is not to improve processing uniformity across the substrate chamber. Instead, *Kondo* pertains to manufacturing of supporter used for a recording medium. As such, it is earnestly believed that *Kondo* does not teach or suggest using the claimed gas chemistries to improve processing uniformity across the substrate. In addition, it is respectfully submitted the mere assertion that a feature in itself may be known, does not establish that the feature in combination with other recited features would have been obvious within the meaning of the 35 U.S.C. §103. Claims 37-41 recite similar gas chemistries.

Accordingly, it is respectfully submitted that claims 31-41 are patentable over the combination of *Lymberopoulos et al.*, and *Hills et al.* for at least these reasons.

In view of the foregoing, it is respectfully submitted that the rejection of claims 36-42 and its dependent claims under 35 U.S.C. §103 is improper and should be withdrawn. Furthermore, it is respectfully requested that the Board reverse the Examiner's rejection and remand the application to the Examiner with directions to allow all claims.

F. THE COMBINATION OF LYMBEROPOULOS ET AL., HILLS ET AL. AND LU ET AL. DO NOT TEACH OR SUGGEST COMBINING RADIAL VARIATION IN A CONTROLLED MAGNETIC FIELD WITH THE CLAIMED REACTANT GAS CHEMISTRIES AND THE CLAIMED MATERIAL IN ORDER TO IMPROVE PROCESSING UNIFORMITY ACROSS THE SUBSTRATE

In addition to the features recited in claim 31, claim 49 recites that at least an inner surface of the plasma processing chamber is made of a material that does not substantially interact with the reactive gas chemistries that are flown into said plasma processing chamber.

The Examiner seems to be asserting that Lu et al. teaches using the claimed material for the inner surface of the plasma processing. (Final Office Action, page 6). Additionally, the Examiner argues that the apparatus limitations do not affect the process in a manipulative sense because one of ordinary skilled in the art would expect this material to react to the same plasma conditions in a similarity. (Final Office Action, page 5-6). The undersigned respectfully disagrees.

The mere assertion that use of SiC is known as not substantially reactive does not establish that use of this material in combination with radial variation in a controlled magnetic field and the claimed reactant gas would have been obvious within the meaning of the 35 U.S.C. §103. As such, it is respectfully submitted that in order to make a prima facie case of obviousness, the Examiner needs to at least assert that Lu et al. teaches using the claimed material with the particular claimed gas chemistries, or at least radial variation in a controlled magnetic field, to improve processing uniformity across the substrate. Instead, the Examiner has merely asserted that it would have been obvious to one skilled in the art at the time of the invention to use the claimed material because the use was known (Office Action, page 6).

Furthermore, it should be noted that claim 49 recites using a material that does not substantially interact with reactive gas chemistries that are flown into said plasma processing chamber. The bounding material is used with respect to particular gas chemistries. The gas chemistries are also selected

to work with the radial variation of the magnetic field to achieve a particular result. In other words, the combination of: material for the inner chamber, the gas chemistries, and the radial variation of the magnetic field work together to further improve processing uniformity across the substrate. Therefore, contrary to the Examiner's assertion, it is respectfully submitted that the bounding material does affect the process in a manipulative sense. Claims 50-56 are dependent directly or indirectly on claim 49.

Accordingly, it is respectfully submitted that the rejection of claims 42-56 under 35 U.S.C. §103 is improper and should be withdrawn for at least these reasons.

G. THE FEATURE OF AT LEAST ONE RADIAL REGION WHICH IS NOT IN AN AXIAL DIRECTION PERPENDICULAR TO THE SUBSTRATE IS SUPPORTED PURSUANT TO 35 U.S.C. 112, FIRST PARAGRAPH.

In the Final Office Action, the Examiner has rejected claim 31 under 35 U.S.C. 112, first paragraph. The Examiner has asserted that the feature of at least one radial region which is not in an axial direction perpendicular to the substrate is not supported. The feature of different radial locations including at least one radial region which is not in an axial direction perpendicular to the substrate was added by an amendment dated February 10, 2003.

The original claim 31, among other things, recites providing an electromagnet arrangement disposed above a plane defined by a substrate as to result in a radial variation in the controlled magnetic field. It is respectfully submitted that a radial variation means having magnetic force fields that are radial (i.e. not perpendicular to the substrate). Thus, it is respectfully submitted that the feature of at least one radial region which is not in an axial direction perpendicular to the substrate is clearly supported on the face of the original claimed language. This feature has been added solely for further clarification of the subject matter regarded as the invention. As such, no further support is believed to be needed.

However, further support can be found, for example, in Figs. 2A and 2B. Fig. 2A illustrates magnetic field lines 140 diverging from an annulus of high magnetic field strength with a radius near half the radius 144 of the chamber 146. (Specification, page 14, lines 21-23)

Accordingly, it is respectfully submitted that the rejection of claims 31 under 35 U.S.C. §112, first paragraph is improper and should be withdrawn for at least these reasons.

9. CONCLUSION

In view of the foregoing, it is respectfully submitted that the Examiner's rejection of claims 31-45 and 49-56 as being obvious over the cited art is erroneous. Accordingly, the rejection of these claims should be reversed.

Respectfully submitted,

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10. APPENDIX A

CLAIMS ON APPEAL

31. (Previously presented) A method for controlling processing uniformity while processing a substrate using a plasma-enhanced process, comprising:

- providing a plasma processing chamber having a single chamber, substantially azimuthally symmetric configuration within which a plasma is both ignited and sustained during said processing of said substrate, said plasma processing chamber having no separate plasma generation chamber;
- providing a coupling window disposed at an upper end of said plasma processing chamber;
- providing an RF antenna arrangement disposed above a plane defined by said substrate when said substrate is disposed within said plasma processing chamber for said processing;
- providing an electromagnet arrangement disposed above said plane defined by said substrate, said electromagnet arrangement being configured so as to result in a radial variation in the controlled magnetic field at different radial locations above said substrate within said plasma processing chamber in the region proximate to said coupling window and antenna when at least one direct current is supplied to said electromagnet arrangement, said radial variation being effective to affect density of said plasma in said region proximate to said coupling window and antenna;
- providing a dc power supply coupled to said electromagnet arrangement;
- placing said substrate into said plasma processing chamber;
- flowing reactant gases into said plasma processing chamber, said reactant gases include a combination of gases, wherein two or more gases of said combination of gases included in said reactant gases is a $C_x F_y H_z O_w$ gas;
- striking said plasma out of said reactant gases;
- changing said radial variation in said controlled magnetic field within said plasma processing chamber in said region proximate to said antenna to

control said density of said plasma when said reactant gases are being flown in said plasma processing and thereby improving processing uniformity across said substrate; and

wherein said different radial locations include at least one radial region which is not in an axial direction perpendicular to said direction.

32. (Original) The method of claim 31 wherein the reactant gases further include one or more gases selected from a group of gases consisting of O₂, N₂, CO, CO₂, SF₆, NF₃, NH₃, Cl₂ and HBr.

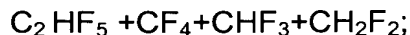
33. (Previously Presented) The method of claim 32 herein the reactant gases further include one or more gases selected from a group of gases consisting of He, Ne, Ar, Kr and Xe.

34. (Previously Presented) The method of claim 31 wherein the reactant gases further include one or more gases selected from a group of gases consisting of He, Ne, Ar, Kr and Xe.

35. (Previously Presented) The method of claim 31 wherein the reactant gases include a gas that is selected from a group of gases consisting of C₅F₈, C₄F₈, C₄F₆, C₃F₆, C₂F₆ and CF₄.

36. (Previously Presented) The method of claim 31 wherein the reactant gases include a gas that is selected from a group of gases consisting of C₂HF₈, C₂HF₅, CHF₃, C₂H₂F₂, C₂H₂F₄ and CH₂F₂.

37. (Previously Presented) The method of claim 31 wherein the reactant gases include a gas that is selected from a group of gases consisting of:



$C_5F_8 + CF_4 + CHF_3 + C_2H_2F_4$;
 $C_4F_8 + CF_4 + CHF_3 + C_2H_2F_4$;
 $C_4F_6 + CF_4 + CHF_3 + C_2H_2F_4$;
 $C_3F_6 + CF_4 + CHF_3 + C_2H_2F_4$;
 $C_2F_6 + CF_4 + CHF_3 + C_2H_2F_4$;
 $C_2HF_5 + CF_4 + CHF_3 + C_2H_2F_4$;
 $C_5F_8 + CHF_3 + C_2HF_5 + CH_2F_2$;
 $C_4F_8 + CHF_3 + C_2HF_5 + CH_2F_2$;
 $C_4F_6 + CHF_3 + C_2HF_5 + CH_2F_2$;
 $C_3F_6 + CHF_3 + C_2HF_5 + CH_2F_2$;
 $C_2F_6 + CHF_3 + C_2HF_5 + CH_2F_2$; and
 $CF_4 + CHF_3 + C_2HF_5 + CH_2F_2$.

38. (Original) The method of claim 37 wherein the reactant gases further include one or more gases selected from a group of gases consisting of O_2 , N_2 , CO , CO_2 and SF_6 .

39. (Original) The method of claim 38, wherein the reactant gases further include one or more gases selected from a group of gases consisting of He, Ne, Ar, Kr and Xe.

40. (Original) The method of claim 37, wherein the reactant gases further include one or more gases selected from a group of gases consisting of O_2 , N_2 , CO , CO_2 , NF_3 , NH_3 , Cl_2 or HBr and SF_6 .

41. (Original) The method of claim 37, wherein the reactant gases further include one or more gases selected from a group of gases consisting of He, Ne, Ar, Kr and Xe.

42. (Original) The method of claim 31 wherein said plasma processing chamber includes an inner surface and at least the inner surface of the plasma processing chamber is made of a material that does not substantially

interact with reactive gas chemistries that are flown into said plasma processing chamber.

43. (Original) The plasma processing system of claim 42 wherein said material of said plasma processing chamber is selected from a group of materials consisting of silicon carbide, quartz, silicon, silicon dioxide, carbon, boron carbide, and boron nitride

44. (Original) The method of claim 31, wherein said plasma processing chamber includes silicon carbide.

45. (Original) The method of claim 31 wherein said plasma processing chamber is made entirely of silicon carbide.

49. (Previously Presented) The method as recited in claim 31, wherein said plasma processing chamber includes an inner surface and at least said inner surface of the plasma processing chamber is made of a material that does not substantially interact with reactive gas chemistries that are flown into said plasma processing chamber.

50. (Previously Presented) The method as recited in claim 49, wherein said material of said plasma processing chamber is selected from a group of materials consisting of silicon carbide, quartz, silicon, silicon dioxide, carbon, boron carbide, and boron nitride.

51. (Previously Presented) The method as recited in claim 49, wherein said material of said plasma processing chamber is silicon carbide.

52. (Previously Presented) The method as recited in claim 51, wherein the silicon carbide of said plasma processing chamber is selected from a group of materials consisting of Chemical Vapor Deposition (CVD), Slipcast Forming, hot-pressed and sintered, iso-statically-pressed and sintered formed silicon carbide.

53. (Previously Presented) The method as recited in claim 49, wherein material forming said inner surface of said plasma processing chamber is provided by a bonded assembly consisting of a suitable material bonded to the chamber wall.

54. (Previously Presented) The method as recited in claim 53, wherein said bonded assembly is bonded with an electrically conductive or a thermally conductive adhesive.

55. (Previously Presented) The method as recited in claim 53, wherein said bonded assembly is configured to reliably form a significant part of the plasma ground.

56. (Previously Presented) The method as recited in claim 53, wherein said bonded assembly is comprised of several segments or tiles of said suitable material bonded to the chamber wall.

APPENDIX B

(Figs. 1, 2A, 2B)

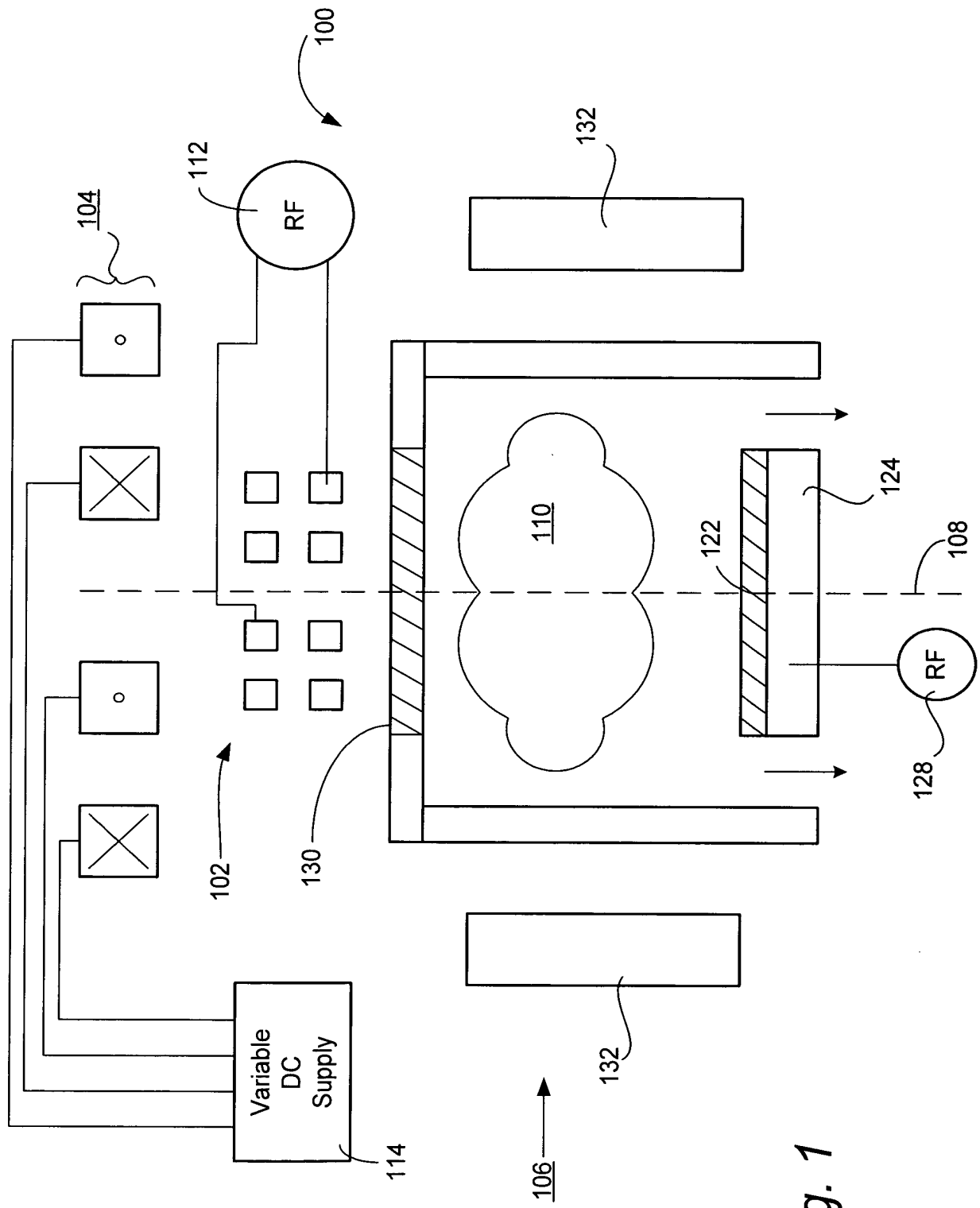


Fig. 1

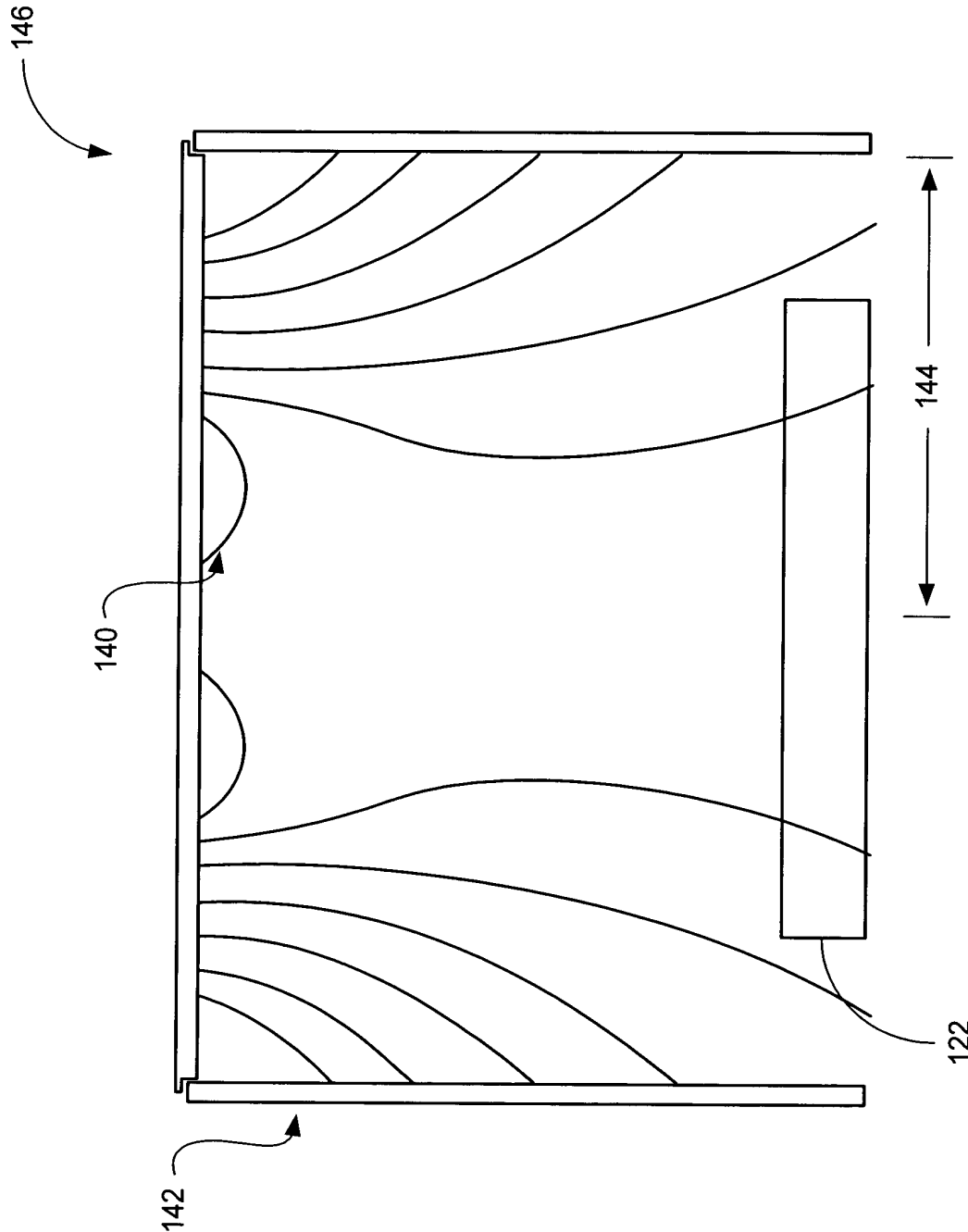


Fig. 2A

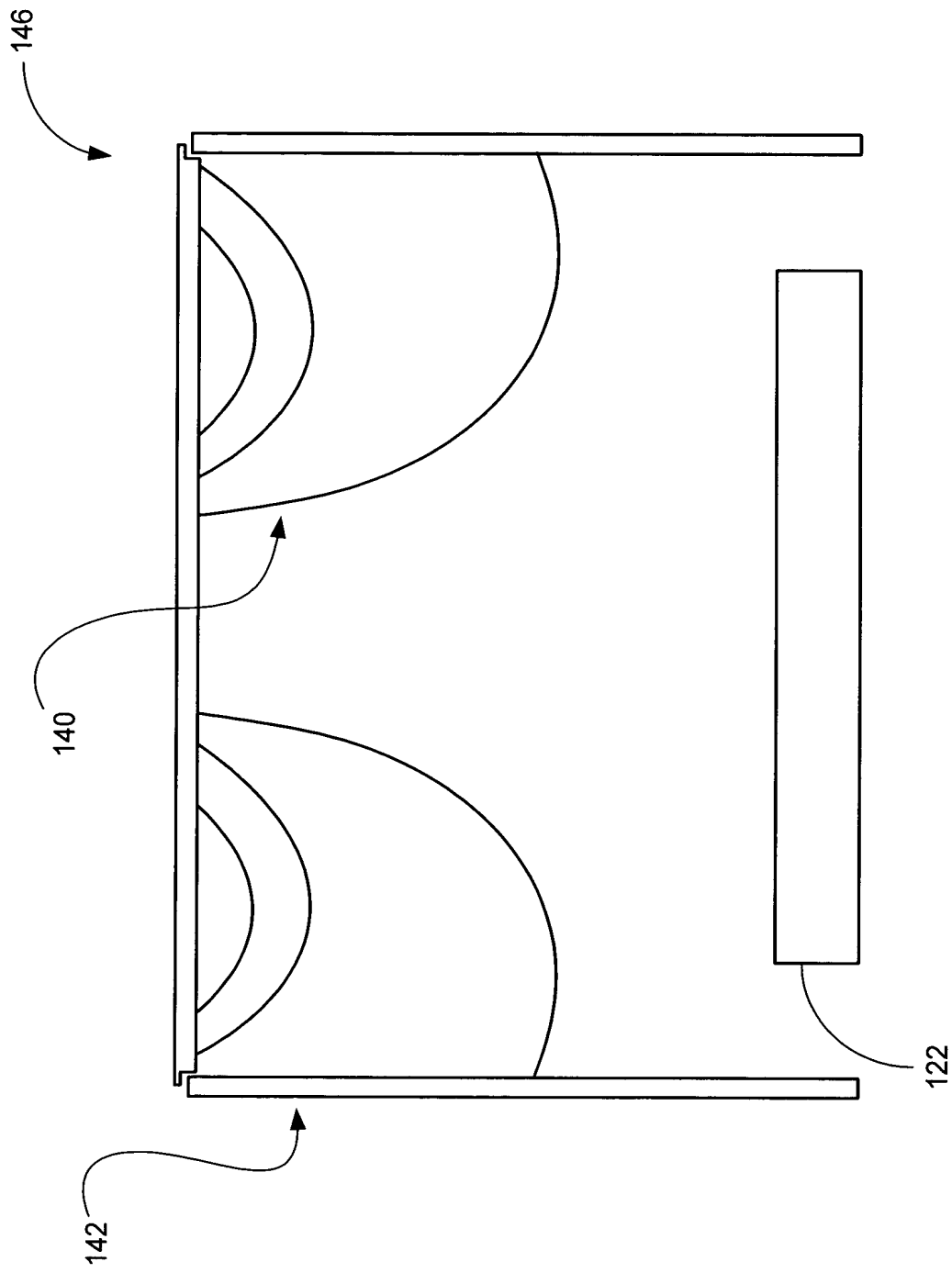


Fig. 2B